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Some Aspects of the Vegetation of the Dandenong Ranges, Victoria

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Abstract: A vegetation survey of the Dandenong Ranges is described and the major vegetation types defined both structurally and floristically. Three analytical survey techniques (two numerical) are briefly compared for their efficiency in this context, particularly in demonstrating environmental trends. Finally, the role this work could play in future vegetation research in the Dandenongs is discussed.

INTRODUCTION

The Dandenong Ranges, an area popular with amateur botanists, has received little attention from professionals despite its impressive vegetation and close proximity to Melbourne. Clifford (1952) began serious studies in the area when he produced a distribution map of its major eucalypts. But this work was never followed up and a description of structure and composition of the vegetation is still wanting.

It is the purpose of this paper to provide this description and at the same time compare the vegetation variation with some broad environmental trends.

SAMPLING METHODS

All data were collected (during the months April to July 1971) from 10 × 10 m square quadrats, selected from the area to be surveyed so that they satisfied the two following criteria:

(i) The area did not show signs of recent disturbance (clearing; soil removal; non-native plants constituting a cover, visually assessed, of 10% or more; presence of refuse, etc.).

(ii) The area was not recently burnt (coppicing trees, blackened trunks, large numbers of seedlings, or fire records that we know of, indicated burning in the previous 10 years).

The reasons for using these criteria were two. First, for a preliminary description of the vegetation it was considered desirable to include as few complicating factors as possible. Thus sampling was biased towards undisturbed, mature vegetation, to lessen the problem of determining possible environmental controllers of vegetation variation. Second, objective sampling techniques, using a regular grid or random selection, were impracticable due to the fragmentation of the vegetation (Pl. 6). Therefore the area was surveyed from aerial photographs to determine the locations of potential quadrat sites, and then checked on the ground using criteria (i) and (ii) (Fig. 1).

The quadrat size was chosen by the minimal area technique (Braun-Blanquet 1964) which was applied at three randomly chosen sites (randomly chosen from a number of sites already considered suitable for sampling), and at each site the point of flattening on the species/area curve was found to be 100 m^2. This technique has been criticized many times in the past (Rice & Kelting 1955, Goodall 1970) but the present authors (and others, e.g. Grunow 1967) believe that despite these criticisms, and because no reasonable alternatives exist, it can still be of use in choosing a quadrat size. It is perhaps worth noting at this point that the area of 100 m^2 also fulfils the less strict criterion of Williams (1971a) that the quadrat size should be large in comparison to the plants it will contain.

In each quadrat all species of vascular plants that were rooted in, or vertically projected over it, were recorded (with the exception of filmy ferns). Each was given a value based on a visual estimate of its cover-abundance using the Braun-Blanquet scale (Table 1). This type of data collecting, although not strictly quantitative, is useful when time is limiting and/or conditions for collecting more accurate data are difficult

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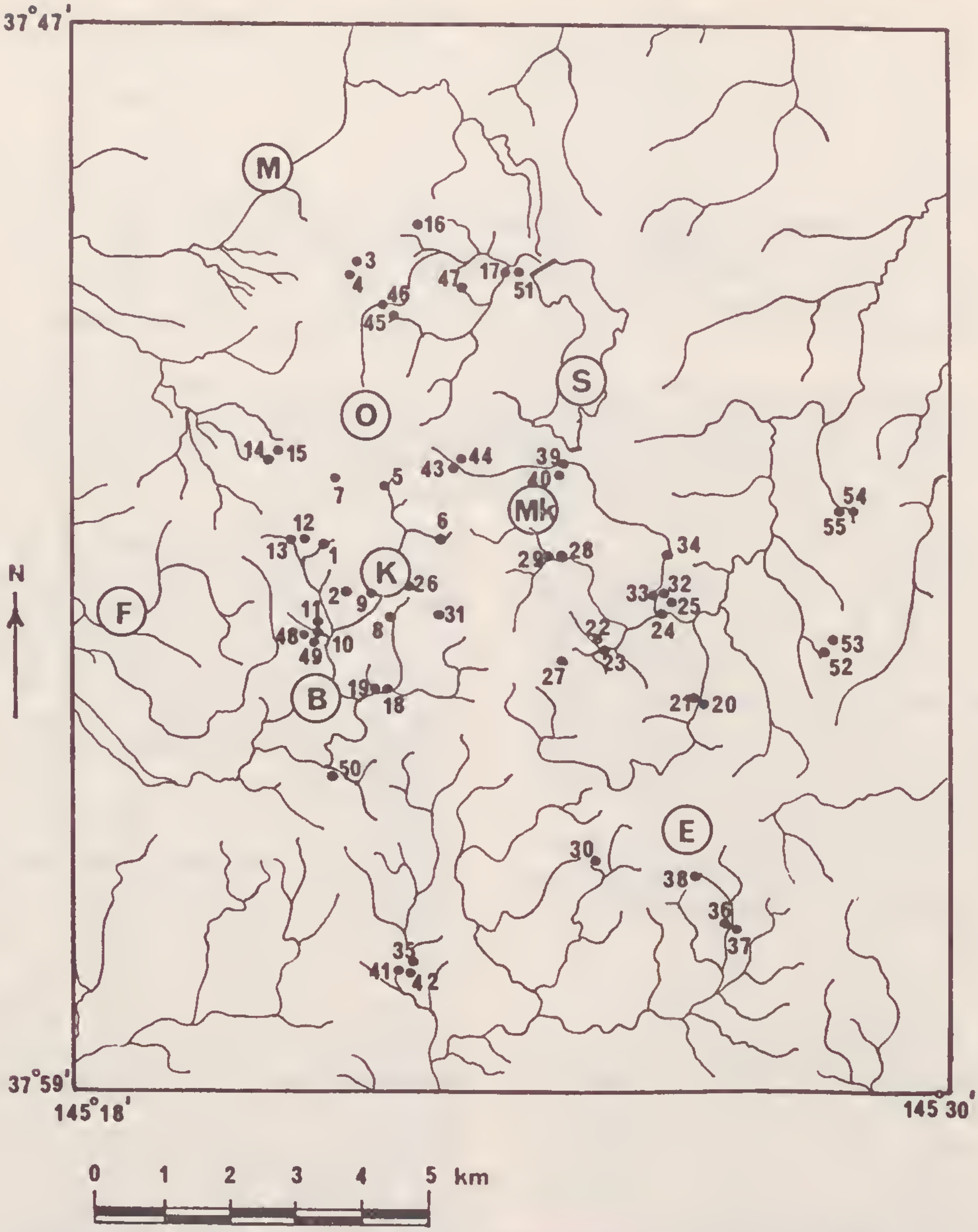

FIG. 1—Map of study area. Black dots are quadrat sites and their numbers correspond to those in Figs. 2 and 3. Encircled letters represent major townships. O = Olinda, F = Ferntree Gully, Mk = Monbulk, M = Montrose, B = Belgrave, E = Emerald, S = Silvan Reservoir.

(Bannister 1966, Kershaw 1968, Noy-Meir 1971).

ANALYTICAL METHODS

As is often the case for primary survey, the choice of the analytical techniques was based on a combination of both theoretical and practical considerations. Practical limitations were imposed by the computer facilities available, which although able to cope with most numerical analyses on small data sets, could not adequately handle the total data collected (a matrix of 55 quadrats and 144 species) using anything but the simplest techniques. On theoretical grounds the maximum information can be gathered from the data if the different, but complementary, strategies of ordination and classification are used together (Anderson 1965). Thus in choosing a classification and ordination system, both economy (in computer use) and efficiency (most workable solution obtainable with the least trouble) were sought.

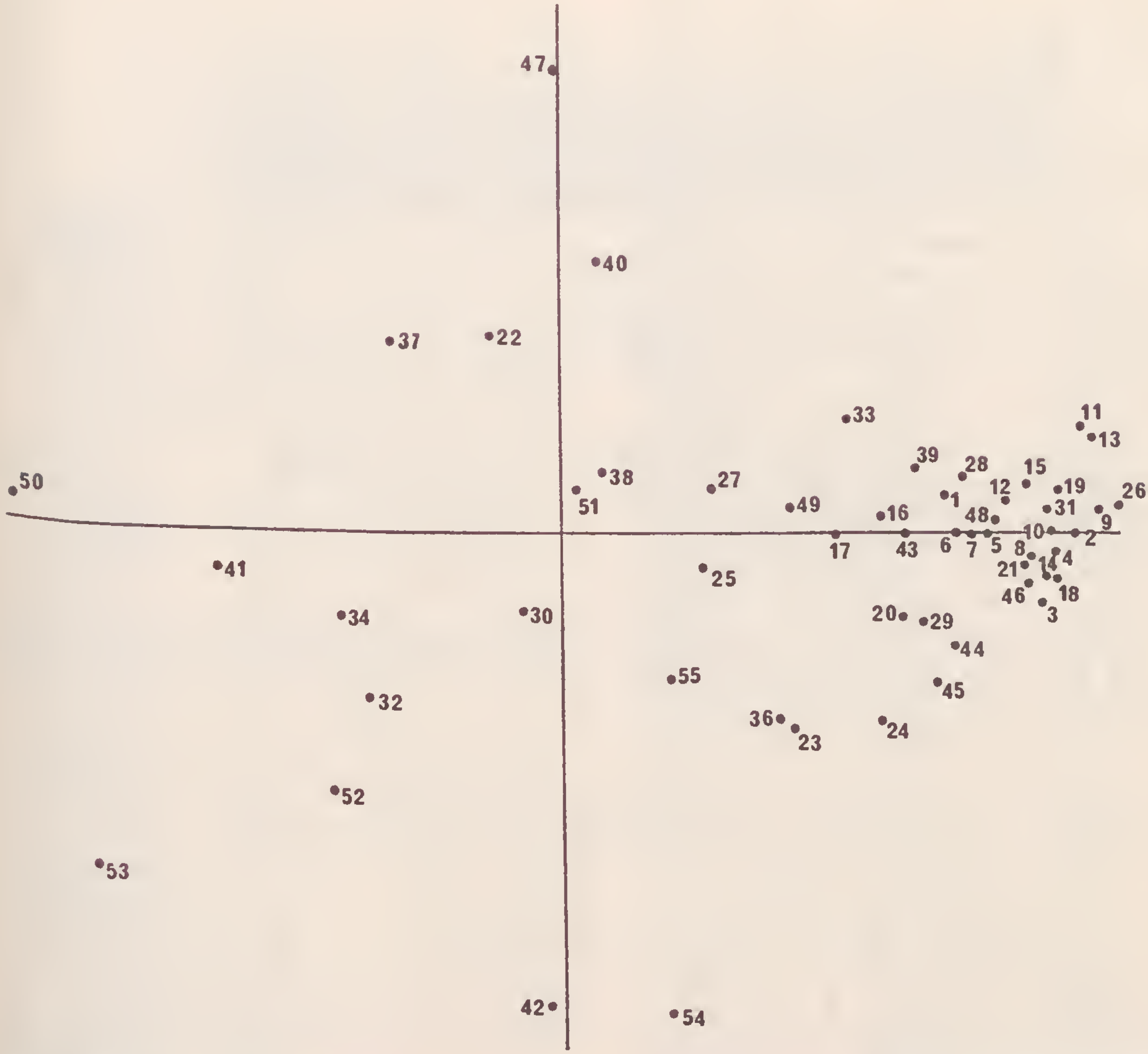

FIG. 2—'Reference set' ordination of the Dandenongs data. Numbers on the diagram correspond to quadrat numbers also represented on the two-way table.

The classification procedure used was the normal and inverse association analysis of Williams and Lambert (1960) (a hierarchial, monothetic, divisive system), and the results were represented on a two-way table as in Lambert and Williams (1962). This technique was chosen because of its success in a wide range of situations (Gittens 1965, Greig-Smith et al. 1967, Grunow 1967, Flenley 1969, Edgell 1969, Allen 1971) and because the computational facilities available to us (a Burroughs 5500) precluded the use of any of the theoretically superior polythetic analyses (Williams et al. 1966, Williams 1971b).

Similarly on theoretical grounds many authors regard principal components analysis (PCA) as the ideal ordination solution (Orloci 1966, Austin 1968, Goodall 1970, Noy-Meir 1971), but once again limited computer facilities meant that a simpler ordination had to be used. Fortunately this did not necessarily mean that the resulting analysis was inferior, for as Beals (1973) points out, PCA was never designed for ecological data, and extensive empirical evidence (from Beals 1973) suggests that Bray and Curtis (1957) 'reference set' ordination (nomenclature Anderson 1971) is probably suitable for a wider range of vegetation types.

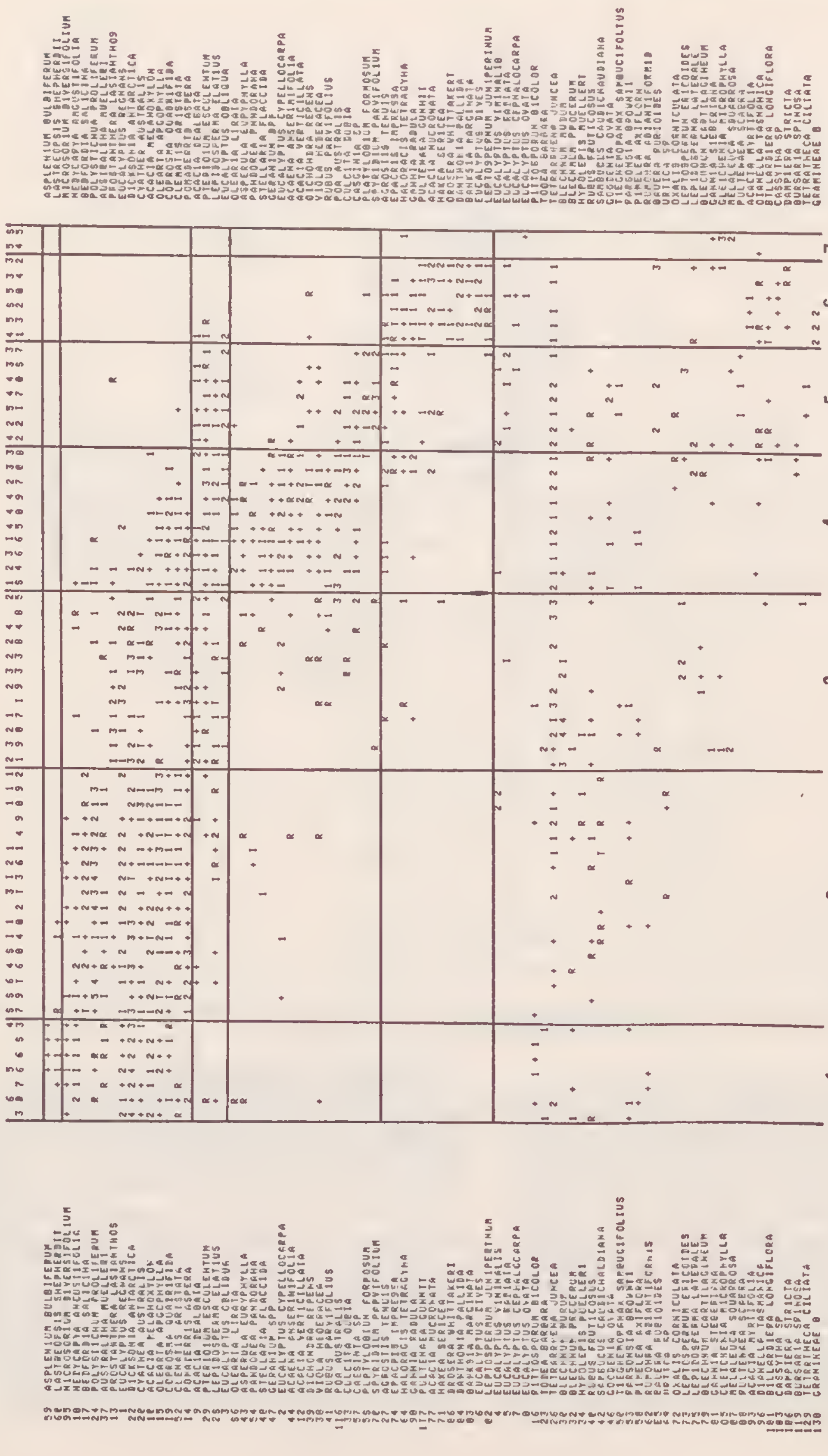

FIG. 3—Numbers across the top represent quadrats and vertical lines delineate quadrat groups. Horizontal lines delineate blocks of frequently co-occurring species. (Note that six extra quadrats have been included. These were collected after the initial analysis was completed but are easily fitted into the existing classification by placing the new quadrats close to those with which they show an affinity. This is a property neither of the numerical analyses possesses).

FIG. 4—Topography of study area measured in feet above mean sea level. Black dots are quadrat sites. The area shown is identical with that of Fig. 1.

The ordination chosen for the Dandenongs study is a reference set type devised by van der Maarel (1969). In principle it is the same as that of Bray and Curtis (1957), and uses the same coefficient of similarity (i.e. the Czekanowski). But it differs in that the choice of reference stands is more likely to produce a spread of quadrats representative of a major gradient in the vegetation. This is primarily because of the use of a 'negative correlation tendency' (NCT) calculation, instead of relying merely on high interstand difference as in the Bray and Curtis method (see van der Maarel 1969, for detailed explanation and practical example).

As well as the ordination and classification techniques a simple procedure of hand-sorting data on a two-way table was employed. This approach is based on the Zurich-Montpellier (Z-M) system of phytosociology (Braun-Blanquet 1964, Bridgewater 1971) except that only cover-abundance values are used in the table (sociability is ignored) and no attempt is made to define the status of the groups in a predetermined hierarchy. Major groups on the table may be formations, associations, alliances, etc., but for the purposes of the analysis only 'noda' (sensu Poore 1955) are sought.

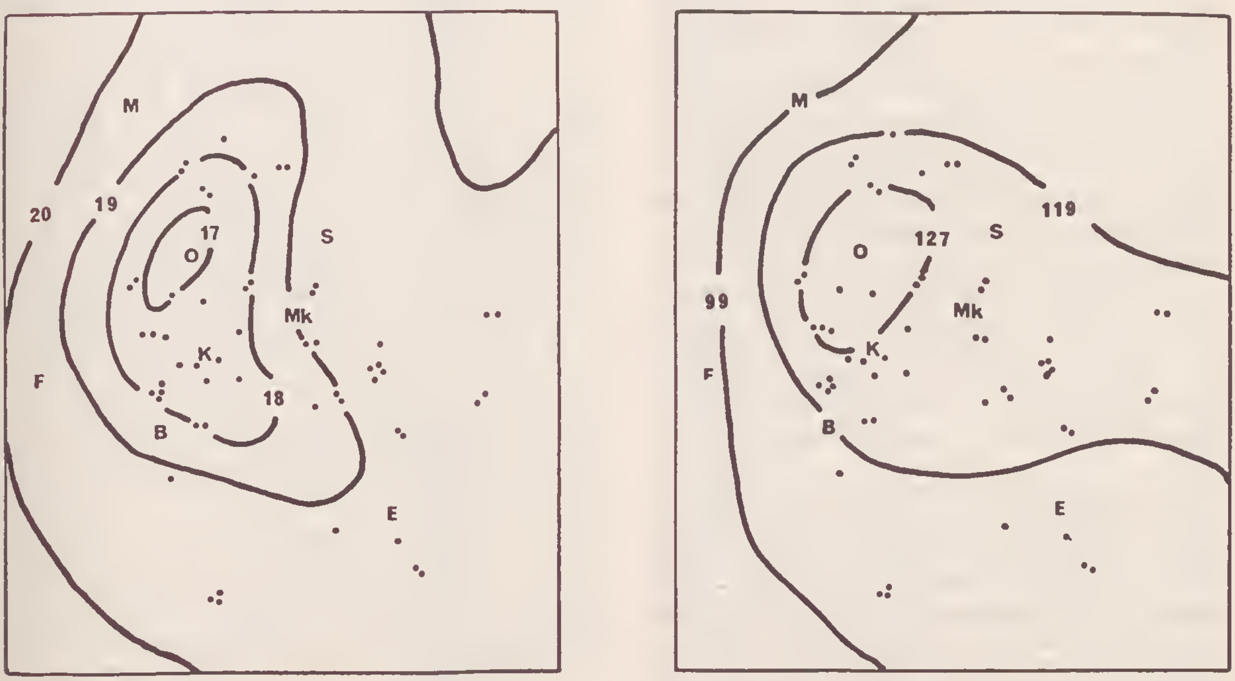

FIG. 5—(a) Average daily maximum temperature (annual) in °C. (b) Average annual rainfall in cm. Dots are quadrat sites and area in both diagrams is identical with that of Fig. 1. Letters represent major townships, e.g. Mk = Monbulk, etc. Data from climatic survey Region 10, Port Phillip, Victoria. Bureau of Meteorology Publication, 1968.

Success with this technique, when compared to more complex numerical approaches (Moore et al. 1969, Dale & Anderson 1972), suggests that it may well prove to be an efficient, rapid method of data processing. The only computer facilities necessary are for a program (ZUMONT/PRINT, written by JRB) which prints the two-way table in a form specified by the user.

RESULTS

The Analyses: The association analysis classification was extremely fragmentary and difficult to interpret in both dendrogram and two-way table forms. Only the first two divisions appeared to form ecologically recognizable groups, and these were very heterogeneous in nature, containing many quadrats with less than 20% of their species in common. As a result, little emphasis was placed on this analysis for producing a final vegetation description.

The ordination was more successful: in general similar quadrats were placed close together on the scatter diagram and the two ends of the major axis of variation represented distinctly different vegetations (Fig. 2).

Both 'quantitative' and qualitative forms of the ordination were calculated (c.f. association analysis where only presence/absence data can be accommodated) but the differences between them was only slight (correlation coefficient 'r' calculated between 55 equivalent random distances on the two ordinations was 0·86; P less than 0·001). Therefore, it was assumed that, for the purposes of this survey, the extra time involved in calculating the ordination from 'quantitative' data was unwarranted, an assertion that van der Maarel (1969) makes for primary surveys in general.

The ordination suggested that the vegetation variation was of a continuous, rather than a discontinuous nature. Several authors have suggested that ordinations usually overemphasize the presence of a continuum, and some (Austin & Orloci 1966) say that this is particularly true of the Bray and Curtis type. However, a comparison of the main vegetation gradient (i.e. the first axis on the ordination) with some broad environmental measurements (see Figs. 4 and 5, altitude; mean annual daily temperature; mean annual rainfall) lends some support to the ordination picture. All parameters appear to follow the main continuous gradient, i.e. there are no sharp changes that might suggest discontinuities in the vegetation.

No detailed soil analyses were attempted in this study, and the authors recognize its incompleteness because of this. However, some idea of the variation in the edaphic environment can be gained by referring to Fig. 6 (a map of the area's geology) and also to the work of Clifford (1952), which gives tentative soil types for different combinations of rainfall and parent material. At this level of resolution all quadrats other than those south of Belgrave and Emerald (see Fig. 1) should be on some form of kraznozem, while the others are on silty-loam podzols. Because of this relative uniformity, and coarseness of resolution, no further attempt was made to compare the vegetation variation with edaphic factors.

Of the three techniques of analysis employed here, the modified Z-M was the most successful. The species and quadrats were sorted on the two-way table in basically the same way as is outlined in Bridgewater (1971) and the final result, unlike the ordination, can show all of the original data. (Although in this case only the most common species, and those characteristic of

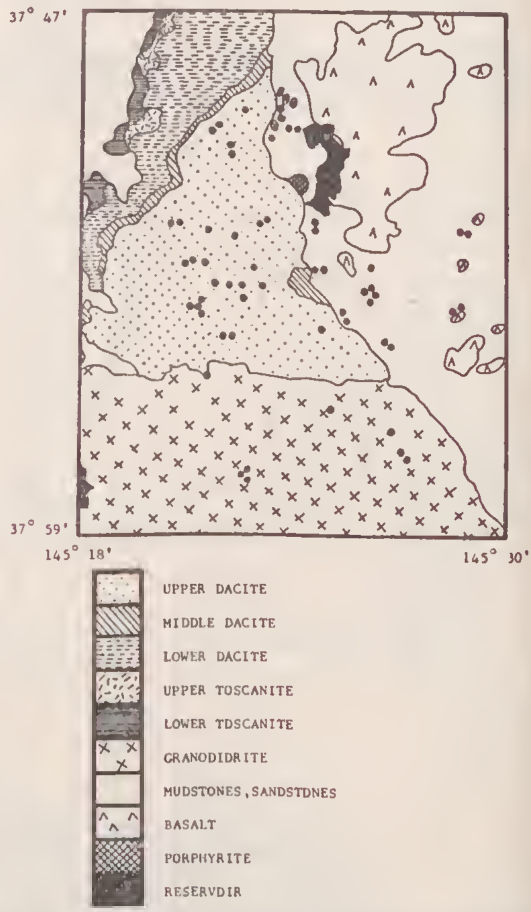

FIG. 6—A simplified geological map of the study area, after Edwards (1955). Black dots are quadrat sites. The area shown is identical with that of Fig. 1.

groups, are shown in Fig. 3, for convenience of representation in this paper, a complete two-way table can be obtained on request to the senior author.) This property is a most useful one as Fig. 3 demonstrates: not only are the major groups and the nature of the variation (continuous or discontinuous) demonstrated, but the constituents of the groups and the species involved in the variation can also be shown.

The two-way table, like the ordination, suggests a fairly continuous change in vegetation, and within this continuum seven groups have been defined (by eye). These groups when plotted on the scatter diagram agree quite well with the ordination, i.e. quadrats in the same groups usually appear close together. Thus the two techniques complement each other and add some confidence to the final description by their close correlation.

The Vegetation: The seven groups defined on the two-way table represent three major types of vegetation which are best developed in groups 2, 4 and 6 (the 3 major noda). Groups 3 and 5 are transitions between these three and group 1 has so much in common with group 2 that it can be regarded as a sub-group, or perhaps a transition between it and another unsampled vegetation. Group 7 consists of two quadrats taken in an isolated patch of vegetation that is entirely different from the rest, and because of the small sample size will not be discussed further.

The arrangement of the groups on the two-way table, as well as corresponding fairly well with the ordination, represents a gradient in the environmental variables mentioned earlier (Table 2). But although the two models of vegetation variation show correlations to these changes in the environment, no cause/effect relationships are proved by them. Nevertheless some supportive evidence of plant/environmental interaction can be obtained by a closer look at the constituent plants of the main vegetation groups.

Groups 1 and 2 can be described (on the basis of structural data collected) broadly as tall open forest (Specht 1970) with a top storey of fairly sparse-canopied trees ranging in height from about 50 to 70 m (e.g. *Eucalyptus regnans*, *E. cypellocarpa*). The understorey consists chiefly of broad-leafed trees (about 3-20 m) and an abundance of pteridophytes, particularly *Polystichum proliferum* and the tree ferns *Dicksonia antarctica* and *Cyathea australis*. (All plant names follow those given in Churchill & de Corona 1972.)

Group 4 is also tall open forest (Specht 1970) but generally top storey heights are less (about 50 m maximum; mainly *E. cypellocarpa* and *E. obliqua*). The understorey contains few pteridophytes, some of the larger woody angiosperms are small-leafed, and the grass *Poa australis* agg. is common. Particularly characteristic of this vegetation is the diversity and abundance of small herbaceous plants (e.g. *Geranium* spp., *Stellaria flacida*, *Dichondra repens*, *Viola hederacea*, *Asperula europhylla*), all of which possess thin mesophytic leaves.

Finally group 6, an open forest (Specht 1970) with a top storey of less than 12 m in height (*E. dives*, *E. radiata*) is characterized by a fairly dense understorey of small-leafed, sclerophyll, woody shrubs.

Thus the transition from group 1 to 6 represents changes in plant life-form as well as floristic variation. While the environmental causative factors involved are almost certainly varied, and include edaphic factors not considered in this study, the variation in plant life-forms is not inconsistent with what would be expected if the environmental parameters in Table 2 were among these causative factors.

DISCUSSION

The vegetation of the Dandenongs, although fragmented and heavily disturbed in places, still maintains a distinctive variation. The continuous nature of this variation suggests that the environmental controlling factors would vary in a similar manner, rather than exhibit sharp discontinuities. And that this is true for some broad climatic changes is quite evident from meteorological information about the area. Nevertheless some problems arise in the interpretation of, and the conclusions one can draw from such information. In particular, the long history of disturbing influences on this area (Coulson 1959) means that the possibility that the observed variation may be largely the result of human interference cannot be ignored. This possibility can be minimized by sampling according to criteria (i) and (ii), but as the human influence is quite old and its effects are not understood, there is no way of eliminating it completely.

Therefore the results of this survey describe some of the Dandenongs vegetation as it stands today. It cannot offer any information about how it will react to any disturbing influences, as the sampling was biased against this and no previous records of the vegetation are available. However, it does supply a basis for future work in that later surveys will be able to determine the effect of further development on the vegetation that is, at present, the least disturbed.

An obvious next step in this survey would be to map the distribution of the major three vegetation types. But this is unfortunately not a useful exercise with the present data, because of the large distances between many of the quadrats and the fairly rapid changes in vegetation, particularly in areas with steep slopes (e.g. quadrats 43, 44 and 40). To produce a viable vegetation map of the study area it would be necessary to conduct more detailed ground surveys to outline the extent of the three groups and the transition zones between them. The present survey should be an aid to this exercise in two ways:

(a) Fig. 3 shows almost complete floristic data for all the sample sites and thus the species most likely to be useful in rapid identification of vegetation type (i.e. those which occur consistently and more or less exclusively in a group) are easily found (Table 3).

(b) Table 2 gives some indication of the type of vegetation one would have expected in areas no longer covered by native forest.

This process of primary sampling followed by extensive groundwork and presumptive reconstruction is the only feasible way of approaching vegetation mapping in fairly large and developed areas such as the Dandenongs.

Table 1

Cover/Abundance Scale and Equivalent Numerical Values

Cover/ Abundance Symbol	*Species Performance in Quadrat*	*Arbitrary Numerical Equivalent*
R	rare, erratic, cover less than 5%	0
+	occasional, cover less than 5%	1
1	common, cover less than 5%	2
2	very common, cover less than 5% or cover 5-20%, any number of individuals	4
3	cover 20-50%, any number of individuals	6
4	cover 50-75%, any number of individuals	8
5	cover 75-100%, any number of individuals	10

Table 2

The Means for Three Environmental Variables Over the Seven Vegetation Groups

Group Number	*Mean Altitude (m)*	*Mean Annual Daily Temp. (°C)*	*Mean Annual Rainfall (cm)*
1	381 m	16	129
2	361 m	16	121
3	253 m	17	121
4	287 m	17	121
5	202 m	18	117
6	195 m	18	117
7	160 m	18	121

Table 3

The Plants Considered to be Characteristic of the Three Major Vegetation Types

Notice that these groups could be tentatively defined and named on the basis of a species of Eucalyptus. *However, it should not be assumed from this that vegetation can necessarily be defined in this way as a general rule: for example, at least three other eucalypts are common in this area but have little value as indicators of general floristic trends.*

Group 1 & 2
Eucalyptus regnans
Polystichum proliferum
Dicksonia antarctica
Cyathea australis

Group 4
Eucalyptus cypellocarpa
Acaena anserinifolia
Poa australis
Geranium spp.

Group 6
Eucalyptus dives
Epacris impressa
Danthonia pallida
Leptospermum juniperinum

ACKNOWLEDGMENTS

The authors wish to thank Dr. P. Bridgewater for helpful discussion on phytosociological techniques, Prof. M. J. Canny for suggestions on the manuscript layout, and Mr. B. F. Fuhrer for aid with photography.

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DESCRIPTION OF PLATE 6

Aerial photograph of the Dandenong Ranges. Melbourne Mapsheet Project No. 766, 100 chains to 1 inch, 1969. Dept. of Crown Lands and Survey. (Reproduced by the permission of the Surveyor-General, Dept. of Crown Lands and Survey, Victoria.)